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Occupational Safety and Health Hazards in Rehabilitation Facilites

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health

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OCCUPATIONAL SAFETY AND HEALTH HAZARDS IN

REHABILITATION FACILITIES

Division of Training and Manpower Development

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health

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INTRODUCTION

The Occupational Safety and Health Act of 1970, Public Law 91-596, is one of the most far reaching Federal laws ever enacted. The purpose of the Act is to "assure, so far as possible, every working man and woman in the nation safe and healthful working conditions . . ." This means that every worker who is even remotely involved in interstate commerce and who is not covered by any other Federal act superseding the Occupational Safety and Health Act, for example the Coal Mine Safety and Health Act, is protected. Even agricultural workers, usually excluded under worker-oriented laws, are covered under this one. Thus the law covers almost every working person: approximately 57 million people in some 4.1 million workplaces. No other piece of worker legislation is so encompassing.

To implement, enforce, and administer its provisions, the Act created two new agencies, one within the Department of Labor and another within the Department of Health, Education, and Welfare.* The Labor Department's Occupational Safety and Health Administration, OSHA, is responsible for overall administration and enforcement of the Act. HEW's National Institute for Occupational Safety and Health, NIOSH, is responsible for primary research and manpower development. Its relationship to OSHA is mainly advisory. In addition, the Act created the semi-judicial Occupational Safety and Health Review Commission which is independent of both the Labor Department and HEW. The Review Commission renders decisions on appeals from aggrieved parties. For the most part, these are employers who feel they have been unjustly cited for an OSHA violation.

The provisions of the Act empower the Occupational Safety and Health Administration and the National Institute

*Now called U.S. Department of Health and Human Services.

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for Occupational Safety and Health to use the following means to accomplish the purpose of the Act:

1. The development and promulgation of occupational safety and health standards;

2. Federal enforcement of occupational safety and health standards;

3. Scientific, medical, and technical research;

4. Occupational safety and health training;

5. The development of a trained corps of occupational safety and health professionals;

6. The development of state occupational safety and health programs to the point where the states can assume enforcement of the law..

In addition to outlining the procedures for accomplishing its purposes, the Act spells out a basic set of worker's rights. It also provides for recordkeeping requirements, the gathering of statistics, the dissemination of information, and the establishment of advisory and study programs.

ORGANIZATIONS INSTITUTED BY THE OCCUPATIONAL SAFETY AND HEALTH ACT

OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA)

OSHA's primary functions are the development, promulgation, and enforcement of occupational safety and health standards. OSHA is the legal administrative unit for implementation of the Act. The Assistant Secretary of Labor for Occupational Safety and Health is the chief administrative officer, and, for all practical purposes, the chief occupational safety and health decision maker. His immediate supervisor is the Under Secretary of Labor. The Act, of

course, places ultimate formal responsibility with the Secretary of Labor.

Organizationally, OSHA is divided into a national office, 10 regional offices, and 54 area offices. Policies and programs, for the most part, are developed in the national office and implemented by the regional area offices.

OSHA is authorized to:

1. Promulgate mandatory occupational safety and health standards and regulations.

2. Modify and improve occupational safety and health standards.

3. Enter factories for inspection purposes.

4. Prescribe regulations for maintaining accurate records.

5. Develop and maintain statistics on occupational safety and health.

6. Establish and supervise programs to train and educate employees on the provisions of the Occupational Safety and Health Act.

7. Make grants to states.

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

The National Institute for Occupational Safety and Health, NIOSH, was established by the Department of Health, Education, and Welfare to carry out research duties under the Act.

NIOSH's responsibilities include:

1. Conducting, directly or by grants and contracts, research, experiments, or demonstrations relevant to occupational safety and health.

2. Developing criteria for dealing with toxic materials and physical agents.

3. Making toxicity determinations on request by employer or employee groups.

4. Conducting directly, or by grants or contracts, educational programs aimed at providing an adequate supply of qualified personnel.

5. Publishing an annual listing of all known toxic substances.

RECOGNITION OF HAZARDS IN THE WORKPLACE

The occupational Safety and Health Act and the regulations that were passed under it make a distinction between health hazards and safety hazards. All of us are familiar with many of the common safety hazards. We are not only familiar with the hazard, but we intuitively understand the seriousness of it.

We do not consciously step in front of fast moving automobiles. We try to avoid tripping over electrical cords lying on the floor. We don't touch hot utensils or stick our hands in open flames.

We do not do these things because we understand the consequences we will suffer if we do. We know, usually through personal experience, that if we trip over a wire the effect is immediate and may be very unpleasant. Because we are all aware of the immediate and unpleasant nature of the physical damage that is likely to occur, we usually take reasonable care to avoid accidents.

Occupational health hazards are a different matter. The effect that a health hazard has on the human body is generally not immediate, although it can be. Occasionally it may take years for the effects of exposure to a health hazard to become evident. As a result it is often difficult to convince people that a particular health hazard really constitutes a danger that must be guarded against.

SAFETY HAZARDS

Safety hazards that are commonly found in industrial facilities include fire hazards, machine guarding hazards, electrical hazards, housekeeping hazards, material handling hazards, and walkway and exit hazards.

In addition to possessing all of the safety hazards that ordinary industrial facilities possess, rehabilitation facilities must also cope with the physical, mental, or emotional handicaps which burden many of their employees. Because of these handicaps, the safety hazards found in rehabilitation facilities are often magnified in seriousness.

Any handicap which interferes with an individual's physical mobility and coordination and with his mental concentration can change an ordinary industrial task into an extremely hazardous one.

Other concerns which are characteristic of rehabilitation facilities include poorly trained staff personnel and outmoded equipment. These factors, which would be serious under normal industrial conditions, assume greatly magnified proportions in the rehabilitation context.

Fire Hazards

Fire is a hazard that everyone recognizes and guards against to some degree. Fire is a hazard in almost every area of every industrial facility. It is a particular hazard in paint spray areas, furniture stripping areas, and paint and solvent storage areas.

Paint should be sprayed only in booths that are designed for paint spraying. The spray booths must be equipped with ventilation systems and explosion-proof switches and lighting fixtures to prevent the accidental ignition of solvent vapors.

Furniture stripping operations must be protected in the same manner as paint spraying operations if flammable solvents are used.

Paint and solvent storage facilities are frequently overlooked in industrial facilities. The proper storage of flammable solvents reduces the likelihood of fire and explosion and the possibility of worker exposure to solvent vapors.

The storage of solvents can be accomplished through the use of flammable storage cabinets or specially constructed storage rooms.

Commercial flammable storage cabinets are available. These cabinets are double-walled, metal cabinets made of 18 gage sheet steel and equipped with a lock.

The National Fire Protection Association allows the use of wood cabinets for the storage of flammable and combustible chemicals. The walls of wood cabinets must be at least one inch thick.

The National Fire Protection Association code limits the quantity of solvents that can be stored in such cabinets to 60 gallons of flammable liquid or 120 gallons of combustible liquid.

These cabinets are equipped with plumbing connections which allow the cabinets to be connected to an exhaust system. The function of the exhaust system is to remove flammable vapors from the cabinet and prevent hazardous accumulations. A suitable exhaust rate for the cabinets is 20 cubic feet per minute.

If large quantities of flammable or combustible liquids must be stored in an industrial facility, a specially constructed storage room may be necessary for adequate fire protection.

- Storage rooms should be constructed of non-flammable materials;
- Equipped with a ventilation system;
- Self-closing fire doors, and a fire extinguishing system;
- The room should be liquid-tight where the walls join the floor.

All electrical outlets and equipment should be well-grounded and of explosion-proof design. All light fixtures in the room should be of explosion-proof design.

If large quantities of flammable organic solvents are dispensed in the facility, the containers must be well

grounded. Most organic solvents do not conduct electricity well, and, when flowing through an opening, generate static electricity. The grounding of the containers will prevent the buildup of static charges and the possibility of sparking.

Solvents that are kept outside of storage cabinets or storage rooms should be kept in safety cans. Safety cans are metal cans designed to reduce the risk of ignition of the flammable liquid stored in them.

Flammable waste materials such as oily rags should be disposed of in approved flammable waste containers and not in ordinary waste containers.

Rehabilitation facilities should have on hand the necessary fire extinguishing equipment for fighting small fires. *Extinguishers and hoses should be readily accessible.* There should be an aggressive educational program which informs workers of the fire hazards and trains them to consciously prevent fires.

Machine Guarding Hazards

The OSHA regulations which govern industrial machinery operation are found in the Code of Federal Regulations, Title 29, Part 1910.212. These regulations require that all machine operators and other employees be protected from such machine-caused hazards as those generated by *the point of operation, ingoing nip points, rotating parts, and flying chips and sparks.*

Examples of safety devices which can be used to provide this protection are:

- Barrier guards
- Two-hand tripping devices
- Enclosures
- Remote control devices
- Electronic safety devices.

Barrier guards are devices which physically block and prevent the machine operator from accidentally inserting

any part of his body into the danger area of the machine. They can be used to prevent operator contact with large zones or areas of large machinery. They can also be used to prevent operator contact with a particular danger point on the machinery. Typical examples of this type of barrier guard are guards to prevent contact with table saw blades, belt sanders, nip points in roller assemblies, nip points in conveyor belt assemblies, and shear blades.

Two-hand tripping devices consist of two buttons or levers which must be activated simultaneously for the machine to cycle. The buttons or levers are placed far enough apart that two hands must be used to activate the machine. This prevents the operator from accidentally placing a hand in the danger zone. These devices are commonly used on presses and baling equipment.

Enclosures are cages or assemblies which completely enclose a moving part. They can be used to guard against hazards from rotating devices such as wheels, shafts, couplings, and saw blades. Enclosures can also be used to guard against shearing actions and flying chips and sparks from machine tools such as lathes. Enclosures are generally easy to fabricate, and they provide excellent personnel protection.

There are a number of remote control and electronic safety devices available which utilize different principles to deactivate machinery if any part of the operator's body is in the danger zone. Information on these devices is available from the manufacturers and suppliers.

Electrical Hazards

Electrical hazards are commonly found in nearly every industrial operation. OSHA has incorporated the National Electrical Code into the OSHA regulations. The code and the OSHA regulations contain basic minimum provisions considered necessary for safety.

Included in the regulations are the following basic requirements:

1. Each disconnecting device, for example a fuse box or circuit breaker, must be legibly marked to indicate its purpose, unless its purpose is evident.

2. Frames of electrical motors, regardless of voltage, must be grounded.

3. Exposed noncurrent-carrying metal parts of fixed equipment that may become energized under abnormal conditions must be grounded under any of the following circumstances:

   — When situation in wet or dangerous locations.
   — When in electrical contact with metal.
   — If operated in excess of 150 volts to ground.
   — When situated in hazardous locations.

4. Exposed noncurrent-carrying metal parts of the following plug-connected equipment, which are liable to become energized, must be grounded or double-insulated and distinctly marked:

   — Portable, hand-held, motor operated tools.
   — Appliances.
   — Any equipment operated in excess of 150 volts to ground.

Housekeeping Hazards

The maintenance of a clean and orderly workplace should be a primary goal of every industrial and rehabilitation facility. Poor housekeeping practices encourage the accumulation of flammable and combustible materials. These materials can either serve as the source of a fire or provide fuel to a fire that has started somewhere else.

If floors are not cleaned periodically, accumulations of oils and other liquids as well as general rubbish and debris can develop. Cluttered and slippery floors and stairs are the causes of many injury-producing slips, trips, and falls.

The use of good housekeeping practices will often enable employees to uncover other hazards such as frayed or broken electrical wires and leaking storage cans.

OSHA housekeeping regulations are found in the Code of Federal Regulations, Title 29, Part 1910.22.

Material Handling Hazards

Material handling hazards are those presented by the equipment and procedures used in moving and storing industrial materials. Industrial equipment which is used for these purposes include forklift trucks, hoists, cranes, slings, chains, and any number of other devices. The OSHA regulations which govern this area are found in the Code of Federal Regulations, Title 29, Subpart N.

The OSHA regulations provide detailed information on the safe and proper uses of powered industrial trucks, overhead and gantry cranes, crawler, locomotive, and truck cranes and derricks. They also provide general information on material storage and handling procedures.

For example, if forklift trucks are being used in a rehabilitation facility, some of the precautions that must be observed are:

- High-lift rider trucks must be fitted with an overhead guard to protect the operator from falling objects.
- All operators must be properly trained.
- The wheels of a powered industrial truck must be blocked if the truck is left parked on an incline.
- If the load being carried obstructs the forward view, the operator is required to travel with the load trailing.

Note that these are merely a sampling of the precautions that must be observed. The OSHA regulations must be consulted for the complete list of safety requirements.

Walkway and Exit Hazards

The OSHA regulations which govern walkway and exit hazards are found in the Code of Federal Regulations, Title 29, Parts 1910.21 through 1910.36.

These regulations cover the following general problem areas:

- Housekeeping,

- Aisles and passageways,
- Covers and guardrails,
- Floor loading,
- Ladders and scaffolding,
- Exits.

The regulations which cover this area are very specific and detailed. However, there are some general requirements that can be listed which provide an excellent starting point for those facilities which are attempting to comply with the regulations.

All rehabilitation facilities in particular should observe the following general requirements:

- All places of employment shall be kept clean and orderly.
- The floor of every workroom shall be kept clean and dry and free of protruding nails, splinters, holes, and loose boards.
- Aisles, loading docks, and doorways must be kept clear and in good repair, and, in cases where mechanical equipment is used, must have sufficient clearance for foot traffic.
- Covers and guardrails must be provided to protect personnel from the hazards of open ditches, pits, and vessels.
- Every building must contain enough exits to permit the proper escape of the occupants in case of emergency.
- The exits must be constructed and arranged so as to provide free and unobstructed egress from all parts of the building.
- Every exit must be clearly marked.

As an example of the detail and specificity of the OSHA standards, we will take a look at some of the regulations covering stairs. For fixed industrial stairs:

- The riser height and tread width must be uniform.
- All treads must be slip resistant.
- The vertical clearance above any stair tread to any overhead obstruction must be at least seven feet, measured from the leading edge of the tread.
- The minimum permissible width of an exit stairway is 28 inches, of other stairways, 22 inches.
- The angle to the horizontal made by the stairs must be between 30° and 50°.
- All stairs should be adequately lighted.
- If the tread width is less than nine inches, the risers should be open.
- If there are four or more risers in the flight, there must be railing on each open side.
- The vertical height of a stair railing must be between 30 and 34 inches.

There are many more specific requirements for stairways, and the OSHA regulations should be consulted in necessary.

HEALTH HAZARDS

The designation "Health Hazards" covers two basic groups of hazardous agents — chemical agents and physical agents.

Chemical agents are the chemical elements and compounds used in industrial operations.

Physical agents are physical phenomena, heat and sound for example, which are common to industrial operations.

Even apparently harmless materials such as sand can be dangerous industrial chemical hazards and cause serious worker health problems. Most sand contains a high percentage of free silica, also known as quartz. The inhalation of fine quartz particles over a period of years causes irreparable damage to the human lung. This quartz-induced disease is known as silicosis and is common among miners, stone workers, and those who frequently use abrasive materials.

Physical agents include such things as sound, ionizing radiation, vibration, ultraviolet radiation, heat, and microwave radiation. Under the right conditions, physical agents can damage the human body. Exposure to physical agents can have both acute and chronic effects.

Exposure to chemical agents can also have acute or chronic effects. An example of an acute effect would be a skin burn caused by contact with a strong acid or lye. Acute effects are those which occur within a short time after exposure to the harmful agent. A chronic effect of chemical exposure is exemplified by the liver cancer that can result from years of exposure to vinyl chloride. The liver cancer usually does not manifest itself until several years after the initial exposure. Chronic effects, then, are those which become noticeable only after a substantial time has passed since the initial exposure.

When we talk about occupational health hazards, these then are the kind of hazards that we mean. To uncover health hazards we must rely on information provided by animal exposure studies and on information extracted from industrial data gathered over a period of years.

Because of the insidious nature of health hazards, cause and effect relationships between health hazards and occupational diseases are often difficult to establish. Now, however, with modern statistical, chemical, and medical techniques, we have been able to establish that chemical compounds and physical agents do cause occupational disease.

With that fact in mind, the Occupational Safety and Health Act of 1970 was passed to protect the millions of working men and women from the dangers of exposure to occupational hazards. The Act did not exempt sheltered workshops from its coverage, and they are just as amenable to its provisions as any other industrial workplace.

HAZARD CONTROL

There are three general techniques used to reduce the hazards of exposure to toxic chemicals and dangerous physical agents. The three techniques are:

- Engineering controls;
- Administrative controls;
- Personal protection.

The preferred method of hazard control is the use of engineering controls to reduce toxic emissions at the source or to isolate the worker from hazardous agents.

Engineering controls is a designation for a broad category of control techniques which encompass not only mechanical devices designed and installed to reduce emission of hazardous agents, but also process changes, equipment and materials substitution, and process isolation. Examples of typical engineering controls are:

- Ventilation systems which remove hazardous dusts generated in machining operations.
- Proper engineering design to reduce noise radiation from ventilation systems.
- The use of damping materials to reduce vibration in machinery and the resulting noise radiation.
- The substitution of electric fork lift trucks for gas operated fork lift trucks.
- The substitution of a less toxic material for one of higher toxicity, for example, the substitution of water base paints for oil base paints.

Administrative controls are work practices implemented by management to minimize worker exposure to hazardous chemical and physical agents. A typical administrative con-

trol is to restrict the amount of time a worker can spend in a hazardous area. Workers can be shuttled from high exposure areas to low exposure areas so that the permissible average exposure is not exceeded.

Personal protection encompasses eye protection, respiratory protection, foot and body protection, and face protection.

The OSHA personal protection requirements for industry are covered in the Code of Federal Regulations, Title 29, Part 1910, Subpart 1. The OSHA regulations require that industrial eye protection should be provided to workers in accordance with the American National Standard for Occupational and Educational Eye and Face Protection Z87.1-1968.

As a general rule, industrial quality spectacles should be worn by all individuals working in shop, laboratory, or warehouse areas.

Safety glasses are not acceptable protection in every situation. Where the danger to the eye is very great, goggles should be worn. High speed machining operations which generate large quantities of flying metal chips and particles are the type of operations for which the worker should wear goggles.

Face shields can be worn over safety glasses or goggles to provide additional eye protection as well as protection for the rest of the face. They are extremely useful for workers who need protection from corrosive liquids.

Respiratory protection is furnished to the user or wearer by a mask which performs one or more of the following functions:

- Removes solid and liquid particles by mechanical filtration.
- Removes vapors by adsorption on charcoal or other adsorbent.
- Removes gases by adsorption on charcoal or other adsorbent.
- Supplies air or oxygen to the wearer.

The OSHA regulations governing respiratory protection are found in the Code of Federal Regulations Title 29, Part 1910.134.

Respirator usage is not intended as a substitute for engineering controls. Respirators should be used when engineering controls are in the process of being installed or when engineering controls have been determined to be not feasible. *Some key points to remember about respirators are:*

- A training program is required for all employees.
- They must be capable of being disinfected.
- They must form a perfect seal with the face; beards are undesirable.
- They must be inspected on a regular basis.

Engineering controls are the preferred method of hazard control. Administrative controls and personal protective equipment can and should be used when engineering controls are judged to be not feasible or when they are in the process of being installed.

EXPOSURE STANDARDS

In recognition of the hazards presented by exposure to industrial chemical agents and to physical agents, the Occupational Safety and Health Administration has established permissible air concentrations for approximately 400 chemical agents.

A permissible air concentration for a particular substance is the maximum allowable atmospheric concentration of that substance to which a worker may be exposed.

The permissible air concentrations are found in volume 29, sections 1910.1000 to 1910.1029 of the Code of Federal Regulations. The permissible air concentrations are given in parts per million, ppm, or milligrams per cubic meter.

Parts per million is a volume per volume term. An example of one part per million is one-half inch in 10 miles. Milligrams per cubic meter is a weight per volume term.

The exposure standards are primarily eight hour, time-weighted values. An eight hour, time-weighted average is an average exposure for an eight hour working day.

There are certain substances which do not have eight hour average exposure limitations but which have a ceiling value which must never be exceeded. These substances have ceiling values because of the speed with which they affect the human body.

The permissible air concentrations are designed for 8 hour per day, 40 hour per week exposures. The numbers are based on the fact that exposed individuals have recovery periods when they are not exposed to a particular toxic agent. The recovery period allows the body to detoxify itself. For this reason permissible air concentrations should never be used to determine the degree of hazard involved in continuous exposures like those found in air pollution exposures.

CHEMICAL AGENTS

Chemical agents can be classified into subgroups on the basis of their physical properties. Chemical agents can exist as gases, vapors, liquids, or solids.

Gases are materials that are in a gaseous state at normal temperature and pressure. Normal temperature and pressure is considered to be 25°C and 760mm Hg.

A vapor is the gaseous form of a substance that is a solid or liquid at standard temperature and pressure.

Solids and liquids are materials that are solid or liquid at normal temperature and pressure.

Industrial processes can emit hazardous chemical agents into the workplace atmosphere where the agents interact with the atmosphere to form a particular physical state. The common physical states of airborne contaminants include:

- Dusts which are airborne suspensions of solid particles generated by handling, grinding, crushing, impact, or detonation of organic or inorganic materials. Dust particles range in size from 0.1 to 25 micrometers.

- Vapors which are the gaseous form of substances which are normally in the liquid or solid state.

- Gases which are formless fluids that can be changed to the liquid or solid state only by the combined effects of decreased temperature and increased pressure.

- Fumes which are airborne suspensions of solid particles generated by condensation from the gaseous state. Many metals form fumes under the right conditions. Typical examples are copper, lead, and iron oxide fumes. Fumes range in size from 0.01 to 5 micrometers.

- Aerosols which is an inclusive term for any suspension of liquid or solid particles in air.

- Mists which are suspensions of liquid droplets generated by condensation from the gaseous to the liquid state or by breaking a liquid into a dispersed state.

- Airborne suspensions of chemical agents in the workplace are extremely hazardous because of the ease with which they can enter the body.

Routes of Entry

Chemical agents have three basic routes of entry into the body:

1. Through the gastro-intestinal tract;

2. Through the respiratory tract; and

3. Through the skin.

In terms of relative importance, the respiratory tract is the most likely route of entry in an industrial situation. Dusts, mists, fumes, vapors, and gases are all readily inhaled into the body. In many cases, the exposed individual is not even aware that he is inhaling a potentially dangerous material into his system.

Gastro-intestinal tract

The gastro-intestinal tract is not a common route of entry in industrial situations. In general, people do not in-

tentionally ingest industrial chemical agents. However, people do ingest industrial chemicals unintentionally in two ways — eating and smoking.

Personal cleanliness and the location of lunchrooms are important factors in controlling ingestion hazards. Lunchrooms should be located well away from areas where extremely hazardous chemical agents are used. Workers should be encouraged to thoroughly clean their hands before eating.

Smoking is another way in which chemical agents enter the gastro-intestinal tract. Cigars and cigarettes get contaminated by dirty hands or surroundings, and the contamination finds its way into the body when the cigar or cigarette goes into the mouth. Smoking should be discouraged or forbidden in all areas where industrial chemicals are in use.

Skin

The skin is often neglected when protective measures are taken against chemical agent exposures. The skin can be a very important route of entry for many hazardous chemicals. The permissible air concentration list in the OSHA Regulations contains the notation "Skin" next to many of the compounds listed. This notation means that these compounds are readily absorbed through the skin and that this route of entry should be carefully guarded against when working with or near that particular compound.

Nearly all pesticides and herbicides are readily absorbed through the skin. Other compounds which are readily absorbed through the skin include hydrogen cyanide, 1,1,2-trichloroethane, acrylamide, and dimethylaniline.

Respiratory tract

The respiratory tract is the most common route of entry into the body for toxic materials. A normal person at rest inhales 5 to 7 liters of air per minute. When working moderately hard, the same person will inhale 25 to 30 liters per minute. During short periods of tremendous exertion an individual will inhale 150 to 200 liters per minute. Thus the individual who works extremely hard will inhale a much greater quantity of toxic material during the course of a work shift than the individual who has a less taxing job.

The lungs have a surface area of 590 to 800 square feet. Throughout much of this area blood vessels lie very close to the surface of the lung. Many of the toxic materials which are inhaled into the lung can readily pass through the skin into the blood stream.

Gases and vapors penetrate readily into the deepest reaches of the lung — the alveoli sacs — where they are readily absorbed into the blood.

The penetration of solid and liquid particles is dependent on the size and nature of the particle. Water soluble particles will often be dissolved in the mucous of the respiratory tract before reaching the alveoli. The penetration of insoluble particles is a function of their diameter.

Typical airborne contaminant particle sizes range from less than 0.01 micrometer to over 25 micormeters. Particles considered to constitute a health hazard are those with diameters below 10 micrometers. This is because the larger airborne particles, particularly those greater than 10 micrometers in diameter, have a much greater probability of being captured in the upper passages of the respiratory system, and subsequently eliminated from the body. Particles down to about one-half micrometer in size, such as smoke or fumes, penetrate deeper but are usually collected on the mucous lining of the airway ducts. Extremely small particles, such as some aerosols, can reach the membrane of the alveolar walls. It is here that the lung is most vulnerable to damage.

Gases and Vapors

Materials that are present in the workplace as gases and vapors are extremely dangerous hazards because of the ease with which they can enter the body.

Many of the industrial operations which are found in rehabilitation facilities are accompanied by the generation of gases and vapors.

The following operations which generate gases and vapors are conducted in rehabilitation facilities:

- Paint stripping
- Degreasing

- Dry cleaning
- Machining
- Spray painting
- Welding
- Heat sealing of plastics

Paint stripping

Paint stripping operations are frequently found in rehabilitation facilities. Paint stripping operations utilize many different organic solvents. Acetone, toluene, xylene, benzene, and methylene chloride are all used for stripping furniture. The quantity of vapor generated by this type of operation can be considerable. All of the solvents used have permissible air concentration limits established by OSHA. They are all recognized health hazards. Benzene is considered to be a carcinogen or cancer-causing chemical.

Vapors are generated in the paint stripping operation by agitation of the stripping solution and by plain evaporation of the material into the atmosphere.

These vapors must be controlled wherever possible. The most desirable approach to controlling worker exposures is to design engineering controls to prevent the emission of hazardous vapors into the workplace. For a paint stripping operation, the most effective engineering control is ventilation. Specially designed enclosures for paint stripping equipment are available, or an effective ventilation system can be custom-designed for a particular paint stripping operation.

Another engineering control that can be used is material substitution. For example, methylene chloride can often be used for paint removal in place of the much more toxic benzene.

In the absence of engineering controls or during the period when engineering controls are being installed, the workers must wear some type of personal protection. For gas and vapor exposures, personal protection consists of respiratory protection.

Workers exposed to toxic vapors and gases can obtain satisfactory respiratory protection by wearing a half mask, air-purifying, chemical cartridge respirator. The cartridge unit contains a filter pad to remove particulate material and a layer of adsorbing material to remove gases and vapors from the inhaled air. The most frequently used adsorbing agent is activated charcoal. Other adsorbents used in respirator cartridges are activated alumina, molecular sieve, and silica gel.

Degreasing

Degreasing operations are used in rehabilitation facilities to clean dirty, metal parts. The degreasing solution can be a combination of solvents or a single, organic solvent. The most commonly used degreasing agents are the chlorinated hydrocarbon solvents and the freon compounds. Some of the chlorinated hydrocarbons are suspected of being carcinogens. Trichloroethylene, one of the more common degreasing agents, is one of the solvents suspected of having carcinogenic properties.

The primary engineering methods for controlling vapor generation from degreasing operations are exhaust ventilation and vapor condensation. Engineering controls can be supplemented with respirators to provide personal protection for exposed workers.

Dry cleaning

The dry cleaning of clothes requires the use of organic solvents. The most commonly used solvent is perchloroethylene, a chlorinated hydrocarbon. Other solvents used include naptha and some fluorocarbons. Naptha is extremely flammable and must be handled with great care.

Perchloroethylene is also known as tetrachloroethylene. It can enter the body by inhalation of the vapor and by absorption of the liquid through the skin.

Repeated contact with perchloroethylene liquid can cause a dry, scaly type of dermatitis. Exposure to high atmospheric concentrations of perchloroethylene may cause nervous system depression, liver injury, and, in extreme cases, anesthetic death.

In order to maintain worker exposure to dry cleaning solvents at a minimum level, all dry cleaning equipment should be connected to an exhaust ventilation system.

Because of the volume of solvent emitted from the dry cleaning operation, a solvent recovery system may be advisable. The recovery system recovers solvent from the cleaning machine emissions and thereby reduces the quantity of solvent emitted to the outside atmosphere and cuts the overall solvent cost.

Machining of metals and plastics

Machining operations can present serious health hazards to the machine operators. The cutting oils and coolants used in machining metals and plastics have been implicated as causative agents in cases of industrial dermatitis and respiratory difficulties. Cutting oils are of three basic types — straight mineral oil, straight fatty oil, or a combination of the two. Cutting fluids and coolants can become contaminated with bacteria if used over a long period of time. This adds an additional hazard to that of the fluid itself.

The machining of plastics can generate dangerous gases and vapors from decomposed plastic. At the point where the tool contacts the plastic, a zone of intense, localized heating develops. The plastic decomposes at this point, and the decomposition products can contain any number of hazardous gases and vapors. Formaldehyde, hydrogen cyanide, phenol, and hydrogen chloride have all been found in plastic decomposition products.

The machining of metals may also produce toxic metal vapors. When materials containing metals with known toxic effects are to be machined, appropriate control measures should be instituted.

The problems arising from machining operations can usually be corrected by the application of local exhaust ventilation. Other techniques that are effective in controlling machining hazards are the substitution of less toxic materials for highly toxic materials and the use of personal protective equipment by the machine operator.

Spray painting

Spray painting is a common surface finishing technique that is routinely used in rehabilitation facilities. The paints that are most commonly used are oil-base paints that contain large quantities of organic solvents.

The number of different organic solvents used in paints and paint-related products, such as thinners and cleaners, exceeds one hundred. The spraying operation, together with the drying stage, puts large quantities of solvents into the atmosphere.

The emission of organic solvents into the industrial atmosphere as a result of spray painting can be minimized by spraying paint only in a ventilated booth which has been designed for that purpose. Paint spray booths should be equipped with explosion-proof switches, lights, and wiring. The spray booth should be inspected regularly for plugged filters and defective exhaust fans.

The emission of organic solvents can be entirely eliminated in some cases by substituting a water-base paint for an oil-base paint.

The painter can get additional protection by wearing an appropriate respirator.

Welding

The welding operation can result in the production of hazardous gases and vapors under certain conditions. The intense heat of the flame or arc will decompose chlorinated organic solvents to form phosgene, a very deadly gas. Welding operations should not be conducted in the vicinity of degreasing or dry cleaning operations in which chlorinated, organic solvents are used.

Hazardous metal vapors and fumes can also be generated during the welding process. For example, if lead alloys are being welded, highly toxic lead fume will probably be present. Arc welding electrodes will ordinarily generate copper, iron, and manganese fumes. These three metals, along with their oxides, can cause metal fume fever.

Welding fumes and vapors are best controlled with exhaust ventilation. Several different hood types as well as

low volume, high velocity systems have proven successful in controlling welding fumes.

Heat sealing of plastics

The heat sealing of plastic films can produce hazardous gases and vapors in the vicinity of the sealing equipment. The plastic in the film, when heated, can decompose to yield any number of toxic hazardous compounds.

Hydrochloric acid vapor, hydrogen chloride gas, vinyl chloride gas, and hydrogen cyanide gas have all been found in the airborne emissions of plastic heat sealing operations. These are all highly toxic chemical compounds.

Workers can be protected from exposure to these compounds by ventilation of the process and by the use of personal protective equipment.

Dusts

The primary sources of toxic dusts in rehabilitation facilities are the metal machining operations. Many of the metal dusts are known to be extremely toxic. If inhaled over a period of time, the effects on the human body can be extremely serious, even fatal in some cases.

Lead dust is a serious hazard to workers. Exposure to the dust can result in fatigue, headache, digestive problems, decreased strength in the hand grip, severe abdominal cramps, wrist drop, convulsions and coma.

Many other metal dusts have similar effects. Aluminum dusts can cause fibrosis of the lung. Chromium dust can cause nasal ulcers. It may also be a carcinogen. Nickel dust can cause severe dermatitis.

The number of different metal dusts and the number of possible effects they can have on the human body are too great to consider in more detail. There are sufficient references available with information on toxic metals and their effects on the human body.

Metal shaping operations which generate dust particles include cutting, grinding, filing, milling, molding, sawing, and drilling. Dust emissions can be controlled by exhaust ventilation and by wetting the operation. Machine operators

can protect themselves with the proper clothing and with respiratory protection.

Metal dusts are not the only hazardous dusts generated in industrial operations. Silica dust or quartz is extremely hazardous and probably accounts for more cases of occupational disease than any other single material. Any type of operation that uses sand as an abrasive material should be carefully evaluated for its potential silica dust hazard.

Asbestos dust is also an extremely hazardous industrial dust. Asbestos is a proven carcinogen. The regulations governing its use, Code of Federal Regulations, Title 29, Part 1910.1001, are very detailed and require the employer to take specific procedural steps if asbestos materials are used in its facilities.

Fumes

Metal fumes are important industrial hazards. Metal fumes can be generated in machining operations, welding operations, metal smelting and pouring, and electrical soldering operations.

Lead, cadmium, iron oxide, zinc oxide, copper oxide, and manganese oxide fumes are all generated in various processes.

Lead and cadmium are extremely toxic. Lead fume is generated when lead metal is melted and maintained in a liquid state. Cadmium fume is found where electrical soldering operations are conducted. Cadmium is a component of electrical solders, and, when the solder is melted, cadmium fume is generated.

The other metal fumes — zinc, copper, and manganese oxides — cause metal fume fever. Metal fume fever is an acute, allergic response to the inhalation of massive quantities of metal oxide fume. The symptoms are a foul taste in the mouth, upper respiratory irritation, chills, weakness, fatigue, and nausea. The symptoms usually disappear when exposure to the fume is discontinued.

Mists

Mists are common industrial hazards. Cutting oil mists generated in machining operations cause more cases of industrial dermatitis than any other chemical agent.

Other important industrial sources of mist are plating operations and cleaning operations which use organic solvents. Chromic acid mists can cause ulceration of the skin and perforation of the nasal septum.

Solvent mists can be extremely hazardous because the mist form results in very high airborne concentrations of solvent. Inhalation of the organic solvent mists can result in severe irritation of the upper respiratory tract and defatting of the lung and respiratory tract tissues. Organic solvent mists must be controlled whenever they occur.

Wood Products

Many workshops, in both their evaluation and production areas work with wood and wood products. These woods, wood dusts, and substances from woods may be toxic, irritant, allergenic, or carcinogenic.

Toxic woods including East Indian satinwood, South African boxwood, and others contain substances, usually alkaloids, which cause systemic signs and symptoms when absorbed, inhaled or ingested. Effects may include headache, loss of appetite, nausea, vomiting, slowing of the heartbeat, shortness of breath, or sleepiness.

Some exotic woods, e.g., manonia, dahomia, and cocobolo, have an irritant effect and may cause injury to the skin and mucous membranes upon contact.

A number of common woods, including certain members of the birch, pine, dogwood, beech, mahogany, mulberry, and maple families, may be allergenic and cause various allergic manifestations such as asthma, contact dermatitis, rhinitis, urticaria and conjunctivitis in sensitized individuals. Western red cedar frequently causes an allergic response. The response occurs after contact with this woods' sawdust and symptoms are intensified by contact with the wood.

There is research which shows a correlation between the inhalation of fine dusts from wood, especially hard wood and nasal cancer. A type of cancer of the nasal mucous membrane (squamous metaplasia) is sometimes found among wood-workers.

In operations that generate wood dust, it is important that proper respiratory protection be provided. Machinery must be equipped with properly installed exhaust equipment in

order to minimize the amount of dust becoming airborne. Work should be carried out in a well ventilated area.

1. *Occupational Diseases, A Guide to Their Recognition*
Revised Edition, June 1977
U.S. Department of Health, Education, and Welfare
National Institute for Occupational Safety and Health
Publication Number 77-181

PHYSICAL HAZARDS

Physical hazards include such things as sound, heat, ionizing radiation, vibration, microwaves, noise, and ultraviolet radiation. Many of the effects of exposure to physical agents are not yet completely understood. The effects of exposure to excessive heat are well known, and most of the effects of exposure to ionizing radiation are now known. The effects of exposure to excessive noise are not yet completely understood.

This apparent lack of knowledge does not mean that there is no basis for formulating exposure limitations and regulating exposures to the physical agents. Enough is known about the effects of all of the physical agents to justify their regulation.

Noise

Exposure to excessive noise for a long enough period of time will cause a permanent loss of hearing in the exposed individual. Other effects of noise exposure include fatigue, annoyance, and a decrease in the ability to perform complex tasks. Also noted at various times and attributed to excessive noise exposure have been physical ills such as circulatory disorders, changes in hormone levels and blood sugar, weight loss, hand tremors, and insomnia.

Ultraviolet Radiation

In the electromagnetic spectrum, ultraviolet radiation falls between the visible light and x-ray bands. The wavelength range of ultraviolet radiation extends from 2900 angstroms to 4100 angstroms.

Exposure to ultraviolet radiation can cause inflamation of the eye and corneal ulcers. Long term exposure to ultraviolet radiation can cause skin cancer.

Ultraviolet radiation exposures are found in welding operations, flame cutting operations, and sterilizing operations in which germicidal lamps are used.

Heat

Heat is a phenomenon that everyone is familiar with. Exposure to excessive heat can result in heat exhaustion and heat stroke. These dangerous effects of heat have been recognized as industrial hazards for many years. However, one important aspect of heat exposures that is not well understood is the effect of heat exposure in conjunction with other health hazards such as chemical agents and the other physical agents. Heat may reduce the body's resistance to chemical agents where the exposures are simultaneous.

Ionizing Radiation, Microwave Radiation, and Vibration

Rehabilitation facilities should not normally encounter problems from worker exposure to ionizing radiation, microwave radiation, and vibration. All of these physical agents are serious health hazards, but they are usually found only in limited use. Vibration is the most widespread hazard of the three, but it is primarily an artefact of heavy industry.

HEALTH HAZARD INTERACTIONS

Individuals exposed to toxic chemical or physical agents can respond in different ways. Factors that can affect the response include:

- The physical condition of the exposed individual.
- The mental condition of the exposed individual.
- The drug burden of the exposed individual.
- The chemical and physical environment of the exposed individual.

There is very little information available about health hazard interactions. We do know that they do occur, and we do know what some of them are.

For example, a worker may possess a physical characteristic which increases his susceptibility to a particular occupational hazard. A well recognized example of this situation is the person with known allergies who is put to work in an area where isocyanates are being used. Isocyanates are chemical compounds which are major components of many industrial adhesives and urethane foams. Exposure to isocyanates can result in a severe, asthma-like attack in sensitized individuals. Workers who are afflicted with existing allergies are readily sensitized to isocyanates. They should never be allowed to work in an isocyanate area.

Other existing physical problems of workers can be aggravated by the nature of their work. Arthritis can be aggravated by a damp, cold, work environment.

Coronary artery disease can also be aggravated by the nature of the work. Exposure to some industrial chemical compounds can have harmful effects on the heart and cardiovascular system. Aniline and nitrobenzene are heart muscle depressants. Many other industrial chemicals, among which are chloroform, trichloroethylene, and ethylene, also irritate the heart in various ways.

The effects of the interaction between a worker's mental condition and the work environment are, in general, poorly understood at the present time. This does not mean that this area should be ignored. Enough is known to indicate that workers with pre-existing mental problems may be more susceptible to industrial chemical exposures. Since noise, which is a physical agent, is a recognized psychological irritant, workers with mental problems should not be exposed to high noise levels.

Another factor which affects the susceptibility of a worker to physical and chemical agents is the drug burden carried by a particular worker. The presence of certain drugs in the body has been shown to enhance the toxic effects of some industrial chemicals.

Phenobarbital, a sedative, has been demonstrated, in animals, to enhance the liver toxicity of carbon tetrachloride, chloroform, and bromobenzene.

Ethanol has been shown to increase the liver toxicity of carbon tetrachloride, chloroform, trichloroethylene, and 1,1,2-trichloroethane.

Undoubtedly other drugs interact with industrial chemicals in a harmful fashion to increase the danger to the worker. The information regarding these drug-chemical agent interactions is extremely scarce. Very little is known about this area of chemical exposures. However, all individuals with occupational health responsibilities should be aware of the potential for harm from these interactions and should seek expert advice when necessary.

The complexity of the physical and chemical environments in which the worker operates can also influence the effect of any particular hazard on the worker. The results of chemical and physical interactions of this type are poorly understood. For this reason caution should be observed whenever complex chemical and physical exposures are encountered. Wherever simultaneous exposures are encountered, advice should be sought from experts in the fields of occupational medicine and industrial hygiene.

SOURCES OF ASSISTANCE

A number of organizations including the Federal government, state governments, and private consultants offer consultative services in the areas of occupational safety and health.

FEDERAL GOVERNMENT

The National Institute for Occupational Safety and Health and the Occupational Safety and Health Administration of the U.S. Department of Labor both provide a variety of services to the private sector.

NIOSH

NIOSH provides several services to the employer.

The NIOSH Division of Training and Manpower Development offers training courses in all areas of occupational safety and health to interested individuals. Courses are

offered in safety, radiation, air sampling, ventilation design, hazard recognition, and legal aspects of occupational safety and health. A complete description of all the courses offered, the fees charged, and a course schedule can be obtained by writing:

NIOSH
Division of Training and Manpower Development
Robert A. Taft Laboratory
4676 Columbia Parkway
Cincinnati, Ohio 45226

In addition to providing training courses, NIOSH provides the following services to employers:

- Health hazard evaluations are performed for employers and employees by NIOSH personnel to evaluate the health hazard presented by the toxic chemical or physical agents.

- Technical information services are provided by NIOSH personnel to answer requests for information on industrial health and safety problems.

- Accident prevention services are provided to assist employers controlling on-the-job injuries resulting from job accidents.

- Industrial hygiene services are provided on request by employers or employees to evaluate hazardous situations and provide advice on control methods.

- Medical services required to solve unusual occupational safety and health problems are provided by NIOSH personnel.

Information on all of the above services can be obtained by writing:

NIOSH
Division of Technical Services
Robert A. Taft Laboratory
4676 Columbia Parkway
Cincinnati, Ohio 45226

OSHA

OSHA provides a limited number of services to employers and employees.

OSHA indirectly provides on-site consultation services through private contractors under the National Emphasis Program and through states which do not have approved occupational safety and health plans by funding the consultation program. All states which have approved plans provide on-site consultation.

OSHA provides a limited number of training and education programs for employers and employees.

Information on the OSHA programs is available from OSHA area and regional offices. They are listed in the local phone books.

STATE GOVERNMENT

State and local governments provide a variety of services which relate to occupational safety and health.

Many states have occupational safety and health programs. Other states handle occupational safety and health operations through their Department of Labor or the Industrial Commission, or the Health Department. Most large cities have bureaus or agencies which are responsible for occupational safety and health.

To attempt to provide specific information for each of the 50 states would be impractical. All states have some type of occupational safety and health program and nearly all of them will provide assistance to the employer.

PRIVATE CONSULTANTS

There are a substantial number of qualified private consultants available to the employer and employee. Lists of qualified industrial hygienists can be obtained by writing the following organizations.

American Industrial Hygiene Association
475 Wolfledges Parkway
Akron, Ohio 44311

American Board of Industrial Hygiene
475 Wolfledges Parkway
Akron, Ohio 44311

A list of qualified safety engineers is obtainable from:

American Society of Safety Engineers
850 Busse Highway
Park Ridge, Illinois 60068

A list of noise control consultants is available from:

National Council of Acoustical Consultants
8811 Colesville Road
Suite 25
Silver Springs, Maryland 10910

CARF STANDARDS

The Commission on Accreditation of Rehabilitation Facilities publishes a standards manual for rehabilitation facilities. The manual contains standards which govern the rehabilitation process itself as well as the condition of the physical facilities.

The CARF manual is entitled *Standards Manual for Rehabilitation Facilities* and is available from:

Commission on Accreditation of Rehabilitation Facilities
2500 No. Pantano Rd.
Tucson, Arizona 85716

There are existing CARF standards which govern safety and health in rehabilitation facilities.

CARF Standard 5.3.1.7 states that a rehabilitation facility shall establish, maintain, and use safety, fire inspection, and public health records and reports.

This standard requires that rehabilitation facilities establish a written plan for the reporting of all accidents on the premises.

CARF Standard 7.2 requires that the physical plant, equipment, and operation of the rehabilitation facility shall meet all applicable legal requirements for design, construction, health and safety. Included under this general provision are requirements for the guarding of machinery, adequate fire protection, adequate exits and fire escapes, adequate ventilation for working areas, and grounding of electrical equipment.

The CARF standards do not cover safety and health matters in great detail. The CARF standards require that a rehabilitation facility comply with all applicable health and safety laws and regulations. As a matter of course, all rehabilitation facilities must comply with the provisions of the Occupational Safety and Health Act of 1970, if they meet the number of employees requirement and the interstate commerce requirement.

The provisions of the Act and the regulations promulgated thereunder spell out in great detail the procedures that industrial employers must take to maintain their facilities is a safe and healthful condition.

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